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Beech Bark Disease

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American beech (*Fagus grandifolia* Ehrh.) is an important component of the northern hardwood forests which occupy about 29 percent of the commercial forest land in the New England and Middle Atlantic States. Even though beech wood has desirable qualities closely akin to those of sugar maple and yellow birch, for a long time beech was discriminated against for lumber and other high-quality products. But now, as improved techniques have made it easier to season and process beech, this species has become quite acceptable in the lumber markets; the wood is used increasingly for a variety of products, such as furniture, flooring, handles, dowels, shuttles, and spools. More beech has also been used as pulpwood, and it may become even more valuable for this purpose.

The growing of large, high-quality beech is complicated by the beech bark disease. This disease has killed more than half the beech in some stands, and many of the surviving trees hold little promise for future production of quality material.

Very little research has been done on the beech bark disease since 1934, possibly because of the old prejudices against beech wood and its low standing in the lumber markets. Most reports on the disease in the past 25 years did little more than tell how rapidly the disease was spreading.

History and Distribution

Accounts from Europe indicate that beech bark disease was killing beech trees before 1849. The obvious scale insect (*Cryptococcus fagi* (Baer.)) on beech was considered the cause until 1914, when it was learned that the fungus *Nectria ditissima* infected the trees infested by the insects.

The insect and probably the associated fungus were introduced into North America on ornamental beech trees. The first reported outbreak of the disease was in 1920 in Nova Scotia, Canada, about 30 years after the insect was known to be present in the area of Halifax. In 1929, the insect was found on ornamental beech trees in the Arnold

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Arboretum in Boston. At the same time, a Nectria was noted on the trees dying after scale infestations in Nova Scotia. By 1932, the disease was known throughout the beech areas of the Maritime Provinces in Canada, in localized areas of eastern and south-central Maine, and in eastern Massachusetts.

Most of the research work on the disease in North America was done at that time. Since then, the disease has continued to spread southward and westward to beech areas throughout the New England States and eastern and central New York.

The disease has been recently reported from areas in western New York and has caused tree mortality in northeastern Pennsylvania. Surveys indicate that the disease is moving south and west at a steady rate. Recently the beech scale, which usually precedes the fungus, was reported in Quebec, indicating a possible northward spread of the disease.

The Cause

American beech *(Fagus grandifolia)*, European beech *(F. sylvatica)*, and all varieties of these species are hosts in varying degrees to the bark-killing fungus, *Nectria coccinea* var. *faginata* Lohman, Watson, and Ayres, which

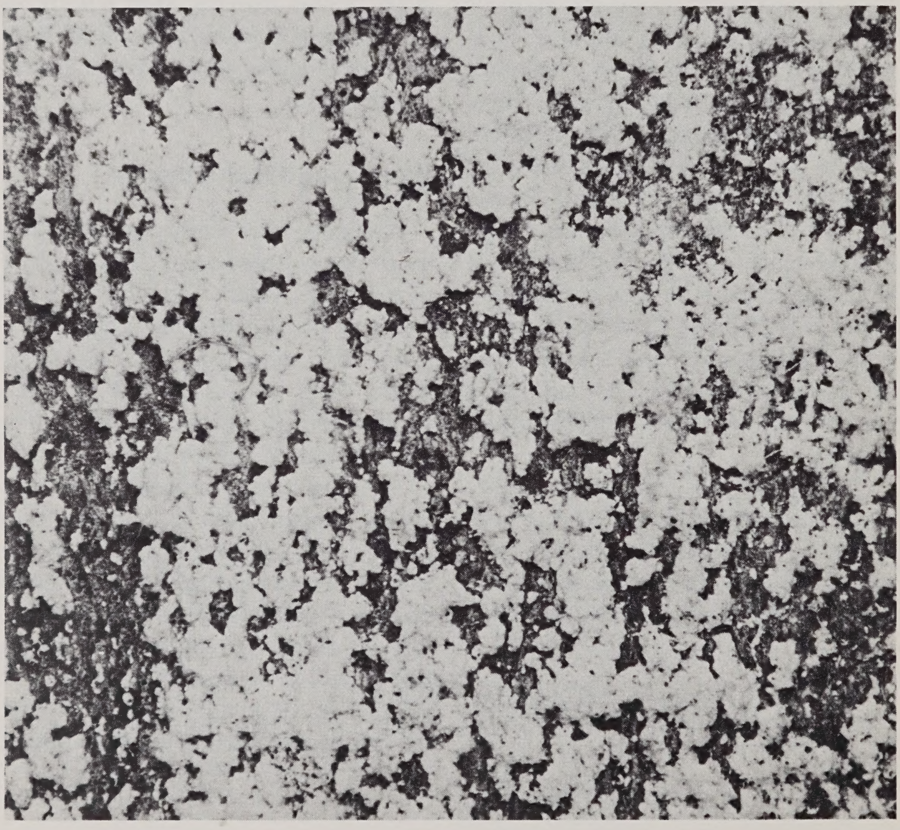

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Figure 1.–A section of beech bark covered with the white wax secretion of the beech scale.

infects through minute wounds and cracks in the bark made by the feeding tubes of the beech scale insect, *Cryptococcus fagi.* Although a fungus and an insect are associated in this disease, the insect was observed first and has been studied in greater detail than the fungus.

In Europe the Nectria first observed associated with *Cryptococcus fagi* was called *Nectria ditissima,* and is now referred to as *N. galligena.* In North America the fungus associated with *C. fagi* is thought to be a variety of a common weakly parasitic species, *N. coccinea* var. *faginata.* Several other species of Nectria have been isolated from some trees showing symptoms of this disease.

The Insect

Cryptococcus fagi is a soft-bodied scale insect. At maturity it is yellow, elliptical, and ½ to 1 mm. long, and it has reddish-brown eyes, a stylet approximately 2 mm. long, rudimentary antennae and legs, and numerous minute glands that secrete a white, woollike wax over its entire body (fig. 1).

Reproduction is parthenogenetic. Beginning in midsummer, the insect deposits pale yellow eggs on the bark in strings of four to eight, attached end to end. Depending on temperature, the eggs usually begin to hatch in late summer, and hatching continues until early winter.

The larvae emerge from the eggs with well-developed legs and antennae. The larvae may remain stationary under the females that died after egg deposition, migrate to cracks and other areas where they will be protected, fall to the ground where death is imminent, or establish themselves on other trees after

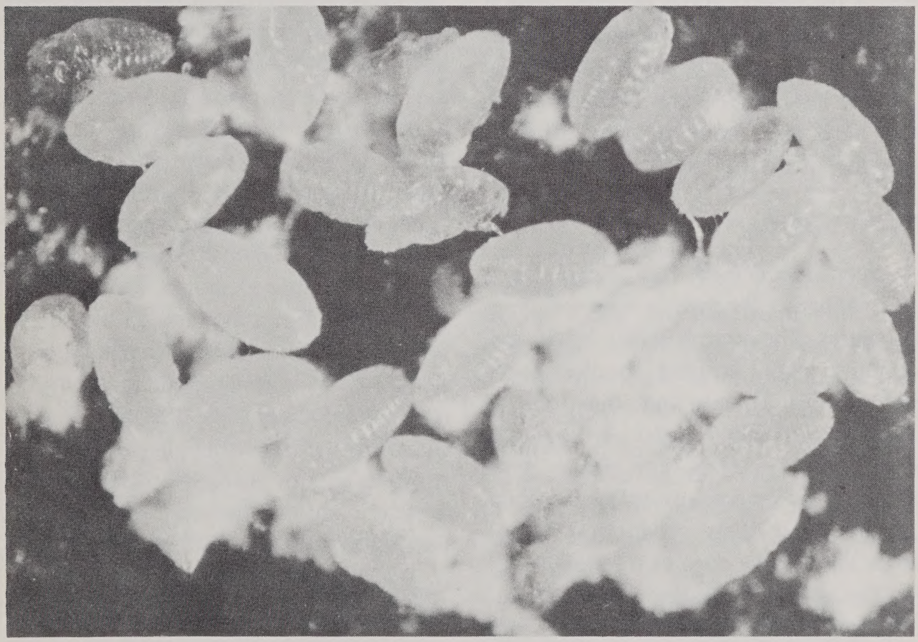

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Figure 2.–Second stage larvae of *Cryptococcus fagi.* The wax was removed before photographing. The larvae are 0.4 to 0.6 mm. long.

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Figure 3.–Fruiting bodies (perithecia) of *Nectria coccinea* var. *faginata*. They may be in clusters up to 40 or in a single line. The perithecia are approximately 0.3 x 0.25 mm.

being disseminated by various agents. After the insect becomes stationary, it forces its tubular stylet into the bark. It is then a second-instar nymph, without legs and covered with woollike wax (fig. 2). The insect hibernates in this stage on the bark and molts in the spring to become an adult female.

The Fungus

Nectria coccinea var. *faginata* is a microfungus that produces several types of spores. The conspicuously bright red, lemon-shaped, fruiting bodies (perithecia) (fig. 3) seen on the trees in clusters of as many as 40 are filled with elongate sacs, each containing eight spores. These spores result from a sexual process, and their production constitutes the perfect stage of the fungus.

The perithecia mature in the fall, and the spores are forced out only when they have been sufficiently moistened. After these spores dry, they appear as white dotes on the tips of the perithecia. Perithecia on the dead bark continue to produce viable spores the following year.

The other types of spores do not follow a sexual process; they are called the imperfect stage. Small white cushions of asexual spores (fig. 4) frequently burst through the bark before the perithecia appear. These can easily be mistaken for small isolated colonies of the scale insect. The asexual spores range from single-celled oval spores to eight-celled sickle-shaped spores. These spores are produced in a dry head, well suited for wind dissemination. The imperfect stage can be found on the trees from midsummer until fall. Because of the variability of the fungi in the *Nectria coccinea* group, there is still confusion over the correct name of the Nectria that follows the scale infestation.

Symptoms and Course of the Disease

First symptoms are isolated dots of white "wool" that appear on roughened areas of the bark, under branches, and in the lenticels. Eventually the entire

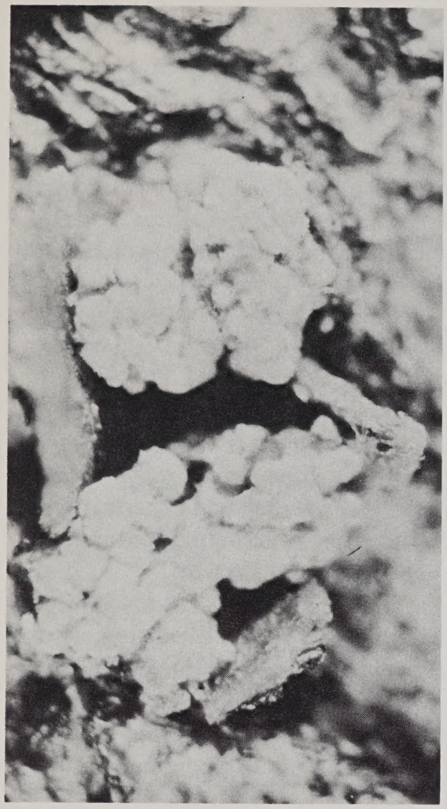

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Figure 4.–The imperfect stage of *Nectria coccinea* var. *faginata,* growing from fungus tissue in the bark. The tufts of sporebearing branches, 1 to 4 mm. broad, can easily be mistaken for isolated colonies of the scale insect.

bole of the tree may be covered with the waxy material secreted by the scale insects as they increase in numbers (fig. 1). Heavy infestations feeding on the liquids in the bark cells can greatly weaken a tree.

On some trees, a red-brown liquid exudes from dead spots near areas heavily infested with the insects. This seeps down the tree, forming a slime-flux or a brown spot. There is no satisfactory explanation for this. The most common theory is that the slime-flux is a secondary effect of the necrosis produced by the feeding of the insects on the cells and that other fungi infest these areas, giving them a foul odor. Frequently perithecia of the Nectria are later found around these dead spots. The dead areas may extend into the sapwood. These spots are usually delimited by callus tissue.

Areas devoid of the scale insects or patches of black wool indicate the first places killed by Nectria: The insects cannot live on dead tissues, and, as they die, a black fungus frequently grows over them. The necessary time and conditions from the first insect infestation to the first fungus infection are not understood, but some are of the opinion that 3 to 6 years are necessary under optimum conditions for infection to be made obvious by the production of the bright red perithecia.

The fungus may infect large areas on some trees, completely girdling them. The leaves that do come out in the spring do not mature, giving the crowns an open appearance. The leaves turn yellow and usually remain on the tree during the summer season. The chlorotic crowns are typical of trees dying from a water deficiency.

Frequently the fungus infects only narrow strips on the bole, and the subsequent symptoms differ from those of trees that have been gridled. Callus tissue forms around these cankers and the bark becomes very roughened (fig. 5). Parts of the crown become chlorotic and die. Small cankers may be walled off from the sapwood by callus tissue (fig. 6).

Other insects and wood-rotting fungi quickly invade the large necrotic areas. Many of the trees that are partially girdled remain alive, in a weakened state, for many years, while others are

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Figure 5.–*Fomes igniarius* and *Hypoxylon* sp. growing on an area killed by the Nectria. Callus tissue has caused the bark to crack along the large lesion. Trees that are not girdled by the Nectria often live a long time.

broken by the wind. Species of *Hypoxylon* that decay sapwood are the first to invade the necrotic areas. Several species of ambrosia beetles facilitate the ingress of other fungi.

Vigorous trees, free of the disease, are often found in heavily infected areas. As some investigators have pointed out, this suggests that some trees are more resistant to the disease than others (fig. 7).

Control

The beech scale insect has very few natural enemies and leads a fairly unmolested life. Air temperatures of -35° F. and lower are lethal to those insects not protected by snow. A ladybird beetle, *Chilocorus stigma,* feeds on the scale; but its effect on the scale population is thought to be negligible.

The fungus *Gonatorrhodiella highlei* is parasitic on the Nectria. This mycoparasite is often found covering large areas of the perfect and imperfect forms of the Nectria. The effect of the fungus on Nectria is not known.

Conflicting reports on the effect of stand density on the progress of the disease have been presented. A program of timely salvage cuttings is the only way presently known to keep the losses from this disease to a minimum.

References

STUDIES OF PYRENOMYCETES: IV. NECTRIA (Part I). C. Booth. Commonwealth Mycol. Inst. Mycol. Pap. 73, 115 p. 1959.

NOTES ON THE BEECH SCALE, CRYPTOCOCCUS FAGI (BAER.) DOUGL., New England. R. C. Brown. J. Econ. Entomol. 27:327-334. 1934.

TIMELY SALVAGE CAN REDUCE LOSSES FROM BEECH SCALE-NECTRIA ATTACK. D. CROSBY and J. C. BJORKBOM. U.S. Forest Serv. Northeast. Forest Exp. Sta. Forest Res. Note 82, 4 p. 1958.

THE BEECH BARK DISEASE, A NECTRIA DISEASE OF FAGUS, FOLLOWING CRYPTOCOCCUS FAGI (BAER.). J. EHRLICH. Canad. J. Res. 10:593-692. 1934.

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Figure 6.—The craterlike scars indicate where small isolated Nectria cankers were walled off by callus tissue. The disease has caused only moderate injury to these trees.

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Figure 7.—The beech on the left is free of scale and Nectria; the one on the right has been recently killed by the disease. This suggests that certain trees are resistant to the disease.

IDENTITY AND HOST RELATIONS OF NECTRIA SPECIES ASSOCIATED WITH DISEASES OF HARDWOODS IN EASTERN STATES. M. L. LOHMAN and A. J. WATSON. Lloydia 6:77-108. 1934.

ANGREB OF CRYPTOCOCCUS FAGI, NECTRIA GALLIGENA OG ANDRE PARASISTER PAA BøG I DANMARK 1939-43. M. THOMSEN, N. F. BUCHWALD, and P. HAUBERG Forstl. Forsgsy. i Danmark. Beret. 18 (157) :97-326. (English summary.) 1949.

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